Impact study of contact angle boundary conditions for CFD simulation of two-phase flow generation in a T-junction

S. Arias[1], A. Montlaur[2]

1) Universitat Politècnica de Catalunya, Spain, santiago.arias@upc.edu
2) Universitat Politècnica de Catalunya, Spain, adeline.de.montlaur@upc.edu

Keywords: Two-phase flow CFD, T-junction, contact angle

Main Topic: Bubble & drop formation, motion, interactions

Gas–liquid two-phase flows dominated by capillary forces occur in countless modern industrial applications. Some examples can be found in normal gravity (mixing process, chemical reactions, emulsion technology, materials synthesis, medical science, personal care products, etc), as well as in space-based systems (life-support systems for human exploration, thermal management systems, propulsion systems, chemical contactors, space bioreactors, etc). A better understanding and an improvement of two-phase flows generation techniques are thus mandatory for the optimal development of these technologies, both in normal and reduced-gravity environments. In the past, great efforts have been conducted to fulfil this goal, and several methods have been proposed, aiming to generate and control two-phase flows in a very accurate way. T-junction bubble generators have arisen as an efficient method providing trains of bubbles, immersed into a continuous liquid, with small dispersion in bubble size.

Very recently, the authors presented a 3D numerical study of the bubble generation process into a T-junction, obtained with the commercial Computational Fluid Dynamics (CFD) solver ANSYS Fluent v15.0.7 [1]. In this study, numerical simulations were compared with experimental data reproducing the same conditions. Numerical data agreed qualitatively but not always quantitatively, with experimental results. Numerical results were found to be very sensitive to the gas-liquid-wall contact angle boundary conditions. Consequently, CFD and experimental results never agreed simultaneously for time scale results (bubble generation frequency) and properties of bubbles detachment (bubble volume and velocity), and the real impact of the value of the gas-liquid-wall contact angle remained an open question.

The study presented here aims to tackle this issue, by explicitly discussing and quantifying the importance of the value of the gas-liquid-wall contact angle. New numerical data is provided and compared with experimental results. A significant better agreement between CFD and experimental results is found (in bubble generation frequency, volume and velocity), and the contact angle is confirmed to be a key parameter in these simulations.

References:

[1] S. Arias, A. Montlaur, Numerical study and experimental comparison of two-phase flow generation in a T-junction, AIAA Journal, March 2017. DOI: 10.2514/1.J055387